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HANDBOOK

FOR

WAVEMETER AN/USM-64(XN-1)

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HANDBOOK

FOR

WAVEMETER AN/USM-64(XN-1)

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UNSATISFACTORY REPORT

In the event of malfunctioning, unsatisfactory design or failure of any part of this equipment, an Unsatisfactory Report shall be submitted to the Bureau of Aeronautics in accordance with current regulations. Such reports shall include:

1. Reporting activity.
2. Number of hours in service.
3. Part which failed.
4. Nature and cause of failure.
5. Remedy used or proposed to prevent recurrence.

SECTION I

GENERAL DESCRIPTION

1. PURPOSE OF HANDBOOK

This manual is prepared for Wavemeter AN/USM-64(XN-1), which is designated by the Sperry Gyroscope Company Division of Sperry Rand Corporation, as the Model 617 Frequency Meter. This manual describes the equipment, covers operation and adjustment, maintenance, and theory of operation, and includes a list of replaceable parts.

2. PURPOSE OF EQUIPMENT

Wavemeter AN/USM-64(XN-1) is a compact, light-weight test set which accurately measures frequencies in the range of from 900 to 12,400 mc and detects the presence of r-f energy in the range with an indication responsive to the r-f energy level. R-f energy may be coupled from a transmission line to the AN/USM-64(XN-1) by coaxial cable, or may be picked up on a special broadband antenna which is supplied. The AN/USM-64(XN-1) may also be operated with an external indicator when a greater sensitivity than that of the internal microammeter is desired.

3. GENERAL PRINCIPLES OF OPERATION

a. Wavemeter AN/USM-64(XN-1) contains two circuits which are essentially independent. The first of these measures frequency accurately by means of a tuned cavity and crystal detector. When the cavity is tuned to resonance, r-f energy is coupled to a crystal detector, rectified, and applied to a microammeter which reads maximum at resonance. Five precision tuned cavities are used to cover the frequency range from 900 to 12,400 mc, with sufficient overlap to insure continuity.

b. The second circuit indicates the presence of r-f energy and utilizes an untuned crystal detector coupled to the microammeter. The meter reading is responsive to the amount of power applied to the circuit.

4. EQUIPMENT SUPPLIED

The equipment supplied and required for operation of Wavemeter AN/USM-64(XN-1) is shown in figure 1-1 and listed in Table 1-1.

TABLE 1-1. EQUIPMENT SUPPLIED

Quantity per Equipment	Nomenclature		Overall Dimensions (inches)			Weight (Pounds)	Sperry Model No.
	Name	Type	Length/ Depth	Width	Height		
1	Test Set	Unit 1	7-3/8	11-3/4	14-3/4		617
1	Cavity, tuned	Unit 2	12	4-41/64	3-45/64		612
1	Cavity, tuned	Unit 3	8-27/32	4-3/4	3-45/64		613
1	Cavity, tuned	Unit 4	8-11/64	4-3/4	3-45/64		614
1	Cavity, tuned	Unit 5	9-5/32	4-17/32	3-45/64		615
1	Cavity, tuned	Unit 6	8-1/4	4-33/64	3-45/64		616
1	Antenna	Unit 7	-----	3-7/32 dia	4-23/32		591
1	Cable Assembly	Unit 8	-----	-----	26		---
1	Cable Assembly	Unit 9	-----	-----	26		----
1	Adapter Tee	UG-107B/U	1-1/2	13/16	1-3/4		---
2	Handbook of Instructions		3/8	9-1/2	11-1/2		Publication No. 23-1180

5. EQUIPMENT REQUIRED BUT NOT SUPPLIED

All equipment required for operation of Wavemeter AN/USM-64(XN-1) is supplied. However, when a greater sensitivity of cavity resonance indication is desired, an auxiliary indicator may be used. The type of indicator used would depend on the nature of the r-f signal. For unmodulated r-f signals a more sensitive d-c microammeter a d-c responsive oscilloscope, or a d-c vacuum-tube voltmeter would be suitable. For modulated r-f signals an a-c oscilloscope or a-c vacuum-tube voltmeter would be appropriate.

6. DESCRIPTION OF COMPONENTS

a. TEST SET

(1) The test set, Unit 1 of Wavemeter AN/USM-64 (XN-1), is constructed on an aluminum panel which serves both as a front panel and as a support. See figure 1-1. On the face of the panel are the two operating controls, the three connectors, the face of the microammeter, and an opening in which the antenna is stored. On the rear of the panel are mounted the various circuit components of the test set.

(2) The panel is mounted in a protective metal case. The case has a removable cover which is fastened closed by eight spring-loaded catches. Storage space is provided within the cover for the handbook of instructions and the two cable assemblies. The adapter Tee is stored in the body of the case.

b. CAVITIES. - Five cavities are supplied, Units 2 through 6 of Wavemeter AN/USM-64(XN-1), to cover the overall frequency range with overlap of bands. See figure 1-1. Each cavity is tunable and includes a calibrated, integral, direct-reading indicator dial. Each cavity incorporates a built-in crystal detector, the output of which is terminated in a type-BNC connector. The connector assemblies are removable for crystal replacement. The cavity in use is installed in a cradle mounting in the test set. The others must be stored externally.

c. ANTENNA. - A special broadband discone antenna, Unit 7 of Wavemeter AN/USM-64(XN-1), covers the entire frequency range of 900 to 12,400 mc. See figure 1-1. The antenna consists of a length of rigid coaxial cable which passes through the apex of a metal cone that is fastened to the outer conductor of the cable. A metal disk is fastened to the end of the center conductor a short distance from

the metal cone with the apex of the cone pointing toward the disk. A type-N connector terminates the opposite end of the cable. A cylindrical plastic radome is sealed to the edge of the disk and the periphery of the cone base for added strength and protection. Storage is provided by an opening in the test-set panel.

d. CABLES AND CONNECTORS

(1) The two cable assemblies are both RG-58/U coaxial cable, 26 inches long overall. The first, Unit 8 of Wavemeter AN-USM-64(XN-1), is equipped with a type-N plug on one end, and a type-BNC plug on the other end. The second cable, Unit 9 of Wavemeter AN/USM-64(XN-1), is equipped with type-N plugs on both ends.

(2) The adapter Tee is an AN type UG-107B/U, with two type-N male connectors and one type-N female connector.

7. ELECTRICAL CHARACTERISTICS

The electrical characteristics of Wavemeter AN/USM-64(XN-1) are summarized in Table 1-2.

TABLE 1-2. ELECTRICAL CHARACTERISTICS

FREQUENCY RANGE	900-12,400 mcs Band 1, 900 to 1,530 mc Band 2, 1,510 to 2,600 mc Band 3, 2,580 to 4,440 mc Band 4, 4,400 to 7,580 mc Band 5, 7,500 to 12,400 mc
ACCURACY	±0.1% for temperature range +20°C (+68°F) to +30°C (+86°F) and relative humidity up to 90%.
	±0.2% for temperature range -40°C (-40°F) to +55°C (+131°F).
SENSITIVITY OF UNTUNED DETECTOR	1 milliwatt for half-scale deflection of microammeter, over frequency range 900 to 8,000 mc.
	3 milliwatts for half-scale deflection of microammeter, over frequency range 8,000 to 12,400 mc.
	D-c return for crystal current is provided internally.
BANDWIDTH OF ANTENNA	900-12,400 mc. The antenna supplied covers the entire frequency range without adjustment.

8. TUBE AND CRYSTAL COMPLEMENT

No vacuum tubes or indicator lamps are used in Wavemeter AN/USM-64(XN-1). One crystal diode type 1N26 is used in the untuned detector and one crystal diode type 1N23B is used in each component frequency meter.

SECTION II

OPERATION AND ADJUSTMENT

1. UNPACKING AND INSPECTING THE EQUIPMENT

After carefully unpacking Wavemeter AN/USM-64(XN-1), check the items received against the list of equipment supplied, Table 1-1 of this handbook, and for evidence of damage. If damage or shortage is detected, report it to the proper authorities at once.

2. PERFORMANCE AND FUNCTIONS OF THE EQUIPMENT

Wavemeter AN/USM-64(XN-1) measures frequency by tuning a calibrated cavity to resonance which is indicated by a peak reading on the microammeter. The equipment also responds to amounts of r-f power as indicated by changes in the microammeter reading. This response is primarily useful for constant frequency signals applied to the untuned detector, but can also be used with the cavity outputs.

3. FUNCTIONS OF OPERATING CONTROLS, CONNECTORS, AND INDICATORS

All operating controls, connectors, and indicators are located on the front panel of Wavemeter AN/USM-64 (XN-1). The front panel is shown in figure 2-1. Each

operating control, connector, and indicator is listed in Table 2-1, together with its reference symbol, purpose, and normal use.

TABLE 2-1. OPERATING CONTROLS, CONNECTORS, AND INDICATORS

Name	Index No. on Figure 2-1	Reference Symbol	Purpose	Normal Settings/Functions
Microammeter	1	M101	Indicates resonance and presence of r-f power.	Indication increases with more power. Tuned for peak reading at resonance, except tuned for null reading when using alternate method (paragraph 5.c. of this section).
DETECTOR INPUT connector	2	J103	Connects input signal to untuned crystal mount.	Used for indication of presence of r-f power. With alternate method (paragraph 5.c. of this section) used in measurement of frequency.
SENSITIVITY control	3	R101	Controls sensitivity of microammeter to all input signals.	Full clockwise position provides maximum snesitivity and maximum microammeter deflection.
Meter switch	4	S101	Connects microammeter to the proper input.	FREQUENCY position connects microammeter to output of the tuned cavity and crystal. DETECTOR position connects microammeter to output of the untuned crystal mount.
OUTPUT connector	5	J102	Connects external indicator to output of tuned cavity and crystal.	Used with oscilloscope, vacuum-tube voltmeter, or sensitive microammeter to indicate resonance of very weak signals.

TABLE 2-1. OPERATING CONTROLS, CONNECTORS, AND INDICATORS (cont)

Name	Index No. on Figure 2-1	Reference Symbol	Purpose	Normal Settings/Functions
FREQUENCY INPUT connector	6	J101	Connects input signal to tuned cavity.	Used for measurement of frequency.
Antenna storage mount	7	----	Antenna storage.	Three thumb screws secure antenna to front panel.
Direct-reading scale on tuned cavity	8	----	Indicates frequency.	Tune for peak reading on microammeter. When using alternate method (paragraph 5.c. of this section tune for null reading.
Tuned cavity	9	Z101	Tunes to resonance with incoming signal.	Install cavity of proper frequency range.
Cavity hold-down clamps and thumb screws	10	----	Holds cavity securely in position.	Tighten during installation of cavity.
Cavity connectors	11, 12	P102 P103	Connect tuned cavity.	Used to connect tuned cavity of appropriate frequency range.

4. OPERATIONAL PRECAUTIONS

a. Modulated signals will display responses at both carrier and sideband frequencies. When using Wavemeter AN/USM-64(XN-1) to measure the frequency of modulated signals, do not confuse the carrier and sidebands. Improper square-wave modulation within the equipment being tested may result in oscillation at two frequencies both of which will also cause response of the test set. Adjusting either the oscillator or the modulator of the r-f source will usually eliminate the second mode.

b. Because of the inherent properties of resonant cavities, Wavemeter AN/USM-64(XN-1) will indicate resonance and produce a microammeter reading for any signal whose frequency is any odd quarter-wave multiple of the frequency to which AN/USM-64(XN-1) is tuned. Therefore, it is absolutely necessary that the operator know approximately the frequency to be measured so that the correct cavity may be chosen to measure that frequency.

c. Extra precaution must be exercised when using tuned cavity unit 5 because this cavity will produce a double response for frequencies in the lower frequency range (approximately 16 percent of total range). This

false response is produced at three times the fundamental frequency. If the frequency to be measured is not known approximately, the cavity should be tuned over its entire range. If a double response is obtained, the lower frequency is the correct one.

d. To prevent damage to the crystal rectifiers in Wavemeter AN/USM-64(XN-1), sufficient r-f attenuation must be used between the signal source and the AN/USM-64 (XN-1) to keep the average input power below 50 milliwatts. Connection to high-power r-f sources should be made through a directional coupler. Also, it should be noted (figure 6-1) that the SENSITIVITY control affects only the microammeter circuit and does not protect the crystal against excessive r-f power.

e. For frequency measurements of highest accuracy, it is necessary to provide additional decoupling beyond that required for crystal protection. If insufficient decoupling is used, the rapid change of Wavemeter AN/USM-64(XN-1) impedance near resonance may cause the signal source to shift frequency.

f. The operator must exercise care when reading the calibrated scales on the tuned cavities, units 2 through 6, because the scale subdivisions are not equal in value

for all cavities nor the same fraction of major divisions. In addition, some portions of some scales can be read to the nearest division for an accuracy of 0.1 percent, while other portions must be interpolated to obtain the 0.1-percent accuracy. Therefore, the operator must identify the value of the smallest division, calculate the percent of accuracy, and then read the scale accordingly.

g. The external detector facility should be used to indicate that r-f energy is being received by the crystal at one or more frequencies in the range of 900 to 12,400 mc. This facility could also be used to indicate a maximum output while tuning an oscillator provided the oscillator frequency remains constant.

h. When using the discone antenna, it should be held with its axis broadside to the direction of propagation of the radiated energy for maximum pickup.

5. OPERATING THE EQUIPMENT

a. DETERMINING THE PRESENCE OF R-F POWER

(1) Since a deflection on the microammeter cannot be obtained until the cavity is tuned to resonance, the presence of r-f power and the relative level of that power must be established prior to making a frequency measurement.

(2) Set the SENSITIVITY control (figure 2-1, item 3) to the mid-scale position (average sensitivity). Place the meter switch (figure 2-1, item 4) in the DETECTOR position.

CAUTION

The SENSITIVITY control does not give protection to the detector or cavity crystal. The input r-f power level must be kept below 50 milliwatts average by inserting sufficient attenuation between Wavemeter AN/USM-64(XN-1) and the source to prevent damage to the crystal rectifiers.

(3) The required connections are shown in part a. of figure 6-3. Connect one end of cable assembly Unit 9 of Wavemeter AN/USM-64(XN-1) (figure 1-1, item 9) to the DETECTOR INPUT connector (figure 2-1, item 2).

Connect the other end to an attentuator or directional coupler which is connected to the equipment under test. The amount of attenuation should be sufficient to produce an on-scale reading. To offer maximum protection to the detector crystal, start with a large amount of attenuation reducing the attenuation until an on-scale reading is obtained.

(4) If an on-scale reading is obtained with the meter pointer very near to the upper or lower limit of the meter scale, adjust the SENSITIVITY control to obtain a more desirable reading.

(5) The microammeter deflection merely indicates the presence of r-f energy. However, any changes in the power level delivered by the equipment under test will be registered by the microammeter. Hence, Wavemeter AN/USM-64(XN-1) may be used to examine the relative effectiveness of tuning procedures or tube replacements of the equipment under test.

b. MEASUREMENT OF FREQUENCY

(1) Perform operating procedures of paragraph 5. a. of this section to determine presence of r-f power and to obtain correct input power level.

(2) Select and install the correct cavity for the frequency to be measured, following the procedure in paragraph 5. f. of this section.

(3) The required connections are shown in part b. of figure 6-3. Disconnect cable assembly, Unit 9 of Wavemeter AN/USM-64(XN-1) from the DETECTOR INPUT connector and connect it to the FREQUENCY INPUT connector (figure 2-1, item 6).

(4) Tune the cavity for maximum reading on the microammeter. Adjust the SENSITIVITY control so that the peak reading is in the upper portion of microammeter scale thus providing maximum sensitivity. Re-tune cavity for maximum reading.

NOTE

Hand pressure on cavity tuning drum may cause an incorrect frequency indication. Therefore, use minimum hand pressure and remove hand from cavity when checking for maximum meter reading.

(5) Read the frequency of the source power on direct-reading scale of cavity (figure 2-1, item 8).

NOTE

To obtain maximum accuracy, operator should observe operational precautions of paragraph 4. of this section.

(6) When measuring the frequency of a low-level source (klystron oscillators, etc.), sufficient decoupling must be used to prevent "pulling" of the source frequency. That is, the source has one frequency before it is coupled to the AN/USM-64(XN-1) and another frequency after it is coupled. To increase the decoupling insert attenuation between the AN/USM-64(XN-1) and the source while adjusting the SENSITIVITY control to a nearly full clockwise position.

(7) If the decoupling necessary to prevent "pulling" of the source frequency reduces the signal level below the sensitivity level of the microammeter with the SENSITIVITY control fully clockwise, a more sensitive auxilliary indicator will have to be used. Refer to paragraph 5. e. of this section.

(8) A discone antenna which is supplied may be used to conveniently couple the AN/USM-64(XN-1) to any r-f source radiating in the operating frequency range without

causing "pulling" of the source frequency. In fact, the discone antenna may be used to check for "pulling" of the source frequency by comparing the frequency readings obtained using the antenna and using the coupling procedure of paragraphs 1 thru 7 above. Refer to paragraph 5. d. of this section.

c. ALTERNATE METHOD OF OPERATION

(1) Wavemeter AN/USM-64(XN-1) may be used as an absorption-type wavemeter, tuning for a minimum indication rather than a maximum. This alternate method of operation indicates the presence of r-f power and measures the frequency of that power in one operation and without requiring changes in cable connections. The accuracy of the frequency measurement, however, is comparatively low and should only be used where a coarse frequency indication is satisfactory. When frequency measurements of highest accuracy are required, the procedure given in paragraph 5. b. of this section should be followed.

(2) A characteristic of all absorption-type frequency measuring devices is that the impedance mismatch between the measuring device and the source (unless sufficient isolation can be used between the two) causes

"pulling" of the source frequency. That is, the source has one frequency before it is coupled to the AN/USM-64 (XN-1) and another frequency after it is coupled. In addition, the impedance mismatch between the adapter Tee and the cavity causes a frequency shift in the point of cavity resonance and accounts for the greater inaccuracy of this method.

(3) Set the SENSITIVITY control (figure 2-1, item 3) to the mid-scale position. Place the meter switch (item 4) in the DETECTOR position.

CAUTION

The SENSITIVITY control does not give protection to the detector or cavity crystal. The input r-f power level must be kept below 50 milliwatts average by inserting sufficient attenuation between Wavemeter AN/USM-64(XN-1) and the source to prevent damage to the crystal rectifiers.

(4) Select and install the correct cavity for the frequency to be measured, following the procedure in paragraph 5. f. of this section.

(5) The required connections for the alternate method of operation are shown in part c. of figure 6-3.

Connect the female connector of Adapter Tee UG-107B/U, (figure 1-1, item 10), to the FREQUENCY INPUT connector (figure 2-1, item 6). Connect one end of cable assembly, Unit 9 of AN/USM-64(XN-1), (figure 1-1, item 9) to a male connector of the adapter Tee and connect the other end of the cable assembly to the DETECTOR INPUT connector (figure 2-1, item 2). Using an additional cable assembly (not supplied) similar to cable assembly Unit 9 of AN/USM-64(XN-1) connect the remaining connector of the adapter Tee to an attenuator or directional coupler, which is connected to the equipment under test. The amount of attenuation should be sufficient to produce an on-scale reading. To offer maximum protection to the detector and cavity crystals, start with a large amount of attenuation reducing the attenuation until an on-scale reading is obtained.

(6) If an on-scale reading is obtained with the meter pointer very near to the upper or lower limit of the meter scale, adjust the SENSITIVITY control for a more desirable reading.

(7) Rotate the cavity tuning drum to be certain that the cavity is not already tuned to resonance with the incoming signal. A steady meter deflection indicates the presence of r-f energy.

(8) Tune the cavity for minimum reading on the microammeter. As the reading decreases turn the SENSITIVITY control clockwise to increase the sensitivity so that the minimum is indicated in the upper portion of the microammeter scale.

NOTE

Hand pressure on cavity tuning drum may cause an incorrect frequency indication. Therefore, use minimum hand pressure and remove hand from cavity when checking for minimum meter reading.

(9) Read frequency on the direct reading scale of the cavity (figure 2-1, item 8).

NOTE

To obtain maximum accuracy, operator should observe operational precautions of paragraph 4 of this section.

d. USING THE DISCONE ANTENNA

(1) The discone antenna, Unit 7 of Wavemeter AN/USM-64(XN-1) (figure 1-1, item 7), may be used for determining the presence of r-f energy and for making

frequency measurements, and requires no connections to the equipment under test. When using the discone antenna for frequency measurements, the r-f field strength must be strong enough to provide adequate deflection of the microammeter pointer, preferably in the upper portion of the scale. The discone antenna will not cause "pulling" of the source frequency.

(2) The required connections are shown in part d. of figure 6-3. Connect cable assembly Unit 9 of AN/USM-64 (XN-1) (figure 1-1, item 9) to the antenna and to either the DETECTOR INPUT connector or FREQUENCY INPUT connector depending on the measurement to be made.

(3) Hold the discone antenna so that its axis is pointing toward the source of the r-f energy. In this position minimum coupling is obtained and maximum protection of the crystal detectors is provided. Slowly tilt the antenna to increase the coupling until a deflection in the upper portion of the microammeter scale is obtained. Maximum coupling is obtained when the antenna is held vertically and at right angles to the direction of propagation.

(4) The discone antenna can be used to check for "pulling" of the source frequency as referred to in paragraph 5. b. of this section. The frequency is first measured as described in paragraph 5. b. and then re-measured using the discone antenna as the coupling device. If the two measurements do not agree, "pulling" of the source frequency is occuring and additional attenuation must be used to provide a greater degree of decoupling as explained in paragraph 5. b. Use of the discone antenna will not cause "pulling" of the source frequency. However, the use of the adapter Tee to connect the antenna to the AN/USM-64(XN-1) may cause a shift in frequency.

e. USE OF AUXILIARY INDICATOR IN FREQUENCY MEASUREMENT

(1) When the decoupling necessary to prevent "pulling" of the source frequency reduces the signal level below the sensitivity level of the microammeter with the SENSITIVITY control fully clockwise, a more sensitive auxiliary indicator must be used. The type of indicator to be used depends upon the nature of the r-f signal. For unmodulated r-f signals a highly sensitive d-c micro-ammeter, a d-c responsive oscilloscope, or a d-c vacuum-tube voltmeter would be suitable. For modulated r-f

signals an a-c oscilloscope or a-c vacuum-tube voltmeter would be appropriate.

(2) The required connections are shown in part c. of figure 6-3. Connect the type-BNC plug on cable assembly Unit 8 of AN/USM-64(XN-1) (figure 1-1, item 8) to the OUTPUT connector (figure 2-1, item 5). Connect the type-N connector on the opposite end of the cable assembly to the external indicator. Set meter switch to FREQUENCY and the SENSITIVITY control fully counterclockwise (minimum sensitivity). Proceed with the frequency measurement as described in paragraph 5. b. of this section, tuning for a maximum reading on the auxiliary indicator.

f. SELECTING AND INSTALLING CAVITIES

(1) Five precision tuned cavities are used to cover the frequency range of 900 to 12,400 mc. The frequency range of each cavity is listed in Table 2-2. Because of the inherent properties of resonant cavities, Wavemeter AN/USM-64(XN-1) will indicate resonance for any signal whose frequency is any odd quarter-wave multiple of the frequency to which the cavity is tuned. Therefore, it is absolutely necessary that the operator know approximately the frequency to be measured.

TABLE 2-2. FREQUENCY RANGES OF CAVITIES

Cavity	Frequency Range
Unit 2	900 - 1530 mc
Unit 3	1510 - 2600 mc
Unit 4	2580 - 4440 mc
Unit 5	4400 - 7580 mc
Unit 6	7500 - 12,400 mc

(2) From Table 2-2 select the cavity that covers the frequency to be measured.

(3) To install the cavity, loosen the three hold-down-clamp thumb screws (see figure 2-1, item 10) and swing hold-down clamps away from cavity cradle. Hold cavity slightly above normal installed position and connect the type-BNC connector (figure 2-1, item 12) to the receptacle on the side of the cavity farthest from the operator. Connect the type-N connector (figure 2-1, item 11) to the receptacle on the side of the cavity nearest the operator. Carefully position cavity on cradle, position hold-down clamps on cavity, and tighten hold-down-clamp thumb screws securing cavity in position. For removal, reverse order of above.

SECTION III

THEORY OF OPERATION

1. GENERAL

This section describes in detail the functioning of Wavemeter AN/USM-64(XN-1). A thorough knowledge of this section will help the operator understand Section II of this handbook, and is essential to the performance of maintenance and trouble shooting.

2. PURPOSE OF EQUIPMENT

Wavemeter AN/USM-64(XN-1) is designed to measure accurately frequencies in the range of from 900 to 12,400 mc, and to detect the presence of r-f energy in this range.

3. DETAILED FUNCTIONING OF ELECTRICAL COMPONENTS

a. CIRCUIT FOR FREQUENCY MEASUREMENT

(1) Refer to the schematic diagram of Wavemeter AN/USM-64(XN-1), figure 6-1. For frequency measurements, r-f signals are introduced at FREQUENCY INPUT connector J101. They are then applied through connectors P101 and P102 to the tuned cavity Z101.

(2) The signal is coupled into the cavity by means of a loop in the cylindrical wall of the cavity. A similar loop couples energy from the cavity to crystal diode CR101, a 1N23B type. Unit 6 employs an input and output iris. Between the two loops and running exactly on the axis of the cavity is inserted a precision metal rod. The insertion length is controlled by a precision drive similar to a micrometer screw, of which the rod is an extension. The empty portion of the cavity beyond the end of the rod performs as a circular waveguide operating below cutoff, and is an open circuit. The other end of the cavity, through which the center conductor projects, is terminated by a shorting quarter-wave trap, which however does not contact the center conductor.

(3) The cavity is electrically a short piece of coaxial line, short-circuited at one end and open-circuited at the other. It is resonant at the frequency for which its length is one-quarter wavelength or any odd multiple thereof. At the resonant frequency, it is excited and contains standing waves. This energy is coupled from the cavity by means of the output loop. At frequencies other than the resonant frequency the cavity is not excited and there is no output. A scale attached to the

precision drive translates penetration of rod into corresponding frequencies; thus the scale is direct reading. This avoids the need for special conversion charts, reduces operator error, and adds convenience and speed in use.

(4) The coaxial line has been designed for resonance at one-quarter wavelength in the three lowest-frequency cavities, Units 2, 3, and 4, and at three-quarters wavelength in the two higher-frequency cavities, Units 5 and 6. However, each is capable of responding to one-quarter wavelength and to any wavelength which is an odd multiple of one-quarter wavelength, i.e., three-quarters wavelength, five-quarters wavelength, etc. Only if the correct response is being used will the AN/USM-64(XN-1) correctly indicate the frequency. Therefore, it is necessary to be certain that the correct cavity is used.

(5) The output loop within each cavity is connected to crystal diode CR101, a 1N23B type mounted within the cavity output connector. The detected r-f energy output is filtered by a built-in capacitor shown on the schematic within the cavity and without a symbol.

This capacitor is formed by the wall and center conductor of output receptacle J105, a type-BNC. The connector assembly is removable for crystal replacement.

(6) Plug P105 is connected to OUTPUT receptacle J102, and to the frequency contact of the meter switch S101. When the switch is in the FREQUENCY position the signal from the cavity is applied to the meter circuit, described in subparagraph 3. a. (2) of this section. Note that OUTPUT receptacle J102 is always connected to the OUTPUT of the cavity, irrespective of the position of the switch.

b. CIRCUIT FOR PRESENCE OF POWER INDICATION

(1) For the presence of power indication circuit, r-f signals are introduced at the DETECTOR INPUT receptacle J103 and applied to crystal diode CR102, a 1N26 type. A built-in fixed resistor, shown in the schematic diagram (figure 6-1) within the crystal mount and without a symbol, provides the d-c path for crystal current on the input side of the crystal. The crystal mount being untuned covers the entire frequency range from 900 to 12,400 mc. The detected signal is filtered by the shunt capacity between the walls and center conductor of the crystal mount.

The detected output is applied through connectors J104 and P104 to switch S101. Note that the detector output is never available at OUTPUT connector J102.

(2) When meter switch S101 is in the DETECTOR position the output of crystal diode CR102 is applied to the meter circuit, composed of microammeter M101, meter shunt resistors R101 and R102, and r-f bypass capacitor C101. Potentiometer R101, the SENSITIVITY control, and resistor R102 form a voltage divider with which to control the meter current.

c. ALTERNATE CIRCUIT FOR FREQUENCY MEASUREMENT

(1) The alternate circuit for simultaneous measurement of frequency and indication of the presence of power (paragraph 5. c. of section II) connects INPUT receptacles J101 and J103 in parallel and places meter switch S101 in the DETECTOR position.

(2) The source energy is rectified by crystal diode CR102 and applied to Meter M101 by way of switch S101, which indicates the presence of r-f energy. Tuning the cavity to resonance at the incoming frequency causes the cavity to absorb energy reducing the meter reading.

SECTION IV

MAINTENANCE

1. GENERAL

Wavemeter AN/USM-64(XN-1) is a rugged unit. However to insure continued reliability simple preventive precautions and checks should be performed periodically. This section lists such procedures, together with directions for the trouble shooting of malfunctions.

2. COMPONENT NUMBERING

The block of numbers 1 to 9 has been assigned for components of Wavemeter AN/USM-64(XN-1). The highest number used is 9.

3. PERIODIC INSPECTION AND PREVENTIVE MAINTENANCE

a. USERS INSPECTION. - Each time Wavemeter AN/USM-64 (XN-1) is used, the user should inspect the equipment for completeness and condition. All discrepancies should be corrected, or reported to the proper authority or organization. The equipment should be kept dry and clean.

b. PERIODIC INSPECTION AND PREVENTIVE MAINTENANCE. - Periodically Wavemeter AN/USM-64(XN-1) should be given a complete inspection as follows:

(1) Remove Wavemeter AN/USM-64(XN-1) from case.

(2) Check for corrosion and fungus.

(3) Check for dirt, grease, and oil.

(4) Knobs should be firmly set upon their shafts.

(5) Meter face should be clean and tight, and should not be cracked.

(6) Connectors should have no nicks, burrs, or damaged threads.

(7) Cables should be free of kinks, nicks, or frayed insulation.

(8) Check cavities for signs of droppage or rough handling.

(9) Check cavity drives for easy, smooth operation.

c. LUBRICATION. - Wavemeter AN/USM-64(XN-1) requires no lubrication.

4. CORRECTIVE MAINTENANCE

a. TESTING AND CALIBRATION. - Normally Wavemeter AN/USM-64(XN-1) will not require re-calibration. However, if the AN/USM-64(XN-1) receives rough handling or if a tuned cavity is dropped, re-calibration may be necessary. In either case the calibration should be checked.

(1) Since Wavemeter AN/USM-64(XN-1) is a precision device, cavity calibration should be performed at depot level by competent personnel using a secondary frequency standard.

(2) The calibration can be performed by using the cavity-contained crystal detector and connecting a sensitive indicating device (refer to paragraph 5. e., section II) to the cavity output connector. A 10,000-ohm resistor must be connected across the terminals of the indicating device if it has a high input impedance to provide a low-impedance path for crystal current.

CAUTION

Do not disassemble cavity units. To do so may destroy the calibration.

b. TROUBLE SHOOTING. - Trouble shooting is facilitated by using the information contained in Table 4-1, the Trouble Shooting Chart for Wavemeter AN/USM-64(XN-1). Trouble shooting requires no special instruments or techniques. Before using the Trouble Shooting Chart, check cable assemblies for defective cables or connectors.

TABLE 4-1. TROUBLE SHOOTING CHART

Symptom	Probable Cause	Remedy
No microammeter indication, one cavity only, METER switch in FREQUENCY position.	Crystal diode CR101 burned out in that cavity only.	Replace the crystal in that cavity. To remove crystal release the type-BNC connector in that cavity.
No microammeter indication, two or more cavities, METER switch in FREQUENCY position (normal indication in DETECTOR position).	Defective connector J101, P101 P102, J105, or P105, or defective cable assembly.	Replace connector or cable as required.
No microammeter indication, METER switch in DETECTOR position (normal indication in FREQUENCY position).	Crystal diode CR102 burned out.	Replace diode.
	Defective connector J103, J104 or P104 or cable assembly.	Replace connector or cable as required.
No microammeter indication in either position of METER switch.	Defective cable.	Replace or repair cable.
	All crystal diodes burned out.	Replace diodes.
	Microammeter M101 burned out or mechanically inoperative.	Replace or repair meter.
	Switch S101 defective.	Replace switch.
	Potentiometer R101 defective.	Replace potentiometer.
	Capacitor C101 shorted.	Replace capacitor.
SENSITIVITY control fails to control meter reading.	Potentiometer R101 defective.	Replace potentiometer.

SECTION V

REPLACEABLE PARTS

1. GENERAL

This section contains a table of replaceable parts for Wavemeter AN/USM-64(XN-1). The listing includes all electrical parts used in the equipment and certain mechanical parts that are resonably subject to loss or failure. Purchased parts retain their original manufacturer's part number. AN, JAN and MIL parts are listed by their respective government assigned numbers and governing specification. Where AN, JAN or MIL designations are used to prefix a part number, extreme care should be exercised in its replacement. Only AN, JAN or MIL parts should be used. The same caution should govern the replacement of all other parts contained in the listing. Individual parts have been chosen for their specific qualities and performance. Use of substitute parts other than those prescribed in the listing may injure or lower the efficiency of the equipment.

2. REFERENCE DESIGNATIONS

This section includes reference designations which correspond to electrical parts appearing on the schematic

diagrams. Each reference designation consists of a letter (or pair of letters) followed by one or more numbers.

3. LIST OF MANUFACTURERS

This section contains a list of all manufacturers of parts used in the fabrication of Wavemeter AN/USM-64(XN-1). The list is arranged in the order of abbreviation designation used in column 4 of the parts table to indicate the manufacturer.

TABLE 5-1. LIST OF MANUFACTURERS

Abbreviation	Name of Manufacturer	Address
IPC	Industrial Products Co. Div. of Knudsen, Inc.	Danbury, Conn.
SPE	Sperry Gyroscope Co. Division Sperry Rand Corporation	Great Neck, N.Y.

TABLE 5-2. LIST OF REPLACEABLE PARTS

EQUIPMENT: Wavemeter AN/USM-64(XN-1)

MAJOR COMPONENT: Wavemeter AN/USM-64(XN-1)

Ref. Desig.	Name of Part and Description	Function	Mfr & Desig. or MIL Type	(Cont) Dwg. or Govt. Spec. No.
101 to 199 Series	WAVEMETER: 900 to 12,400 mc range, ±0.1% accuracy; 5 interchangeable frequency meters; dc ammeter type 0 to 50 ma rating; 1N26 crystal type rectifier; no operating power requirements; aluminum case; gray finish on case; over-all dim., 14-3/4 in. lg, 11-3/4 in. w, 7-3/8 in. high, accessories c/o 1 antenna, 1 box and panel assy, 2 cables, and 5 interchangeable frequency meters	For frequency measurement and detection of signals	SPE 619195	619195
C101	CAPACITOR, FIXED, MICA DIELECTRIC: 10,000 uuf, ±5%; 300V DC	Meter by-pass	CM35B103J	0161-28 MIL-C-5A
CR101	CRYSTAL UNIT, RECTIFYING: silicon crystal; over-all dim., excluding terminal, 0.630 in. lg, 0.294 in. dia	Rectifier	1N23B	824256-1 MIL-E-1B
CR102	CRYSTAL UNIT, RECTIFYING: silicon crystal; over-all dim., 3/4 in. lg, 0.218 in. dia	Rectifier	1N26	825006-1 MIL-E-1B

TABLE 5-2. LIST OF REPLACEABLE PARTS (Cont)

EQUIPMENT: Wavemeter AN/USM-64(XN-1)

MAJOR COMPONENT: Wavemeter AN/USM-64(XN-1)

Ref. Desig.	Name of Part and Description	Function	Mfr & Desig. or MIL Type	(Cont) Dwg. or Govt. Spec. No.
H101	SCREW, EXTERNALLY RELIEVED BODY: Steel, BuAer Spec No. QQ-S-763, Class 7, Type A, 50,000 psi min yield strength, 80 to 90 Rockwell hardness; immunized finish; 12 pitch diamond knurled head, 0.062 in. by 0.062 in. slot, 3/8 in. dia, 3/8 in. high; 0.145 in. dia externally relieved body, 1/2 in. lg; 0.190 (No. 10) in nominal OD thread, 32 per in., NF series, class 2A fit, 3/8 in. lg	Holds panel, antenna, and adapter tee in place	SPE 887167	887167
H102	SCREW, EXTERNALLY RELIEVED BODY: steel, BuAer Spec No. QQ-S-763, Class 7, Type A, 50,000 psi min yield strength, 80 to 90 Rockwell hardness, immunized finish; 12 pitch diamond knurled head, 0.062 in. by 0.062 in. slot, 3/8 in. dia, 7/16 in. high; 0.145 in. dia externally relieved body, 5/8 in. lg; 0.190 (No. 10) in. nominal OD thread, 32 per in., NF series, class 2A fit, 3/8 in. lg	Tightens retaining clamps for frequency meters	SPE 887168	887168
J101	CONNECTOR, RECEPTACLE: 1 female contact; straight	Input connector to frequency meter	UG-1052/U	735827 Navy Dwg RE49F402

J102	CONNECTOR, RECEPTACLE: 1 male contact one end, one female contact other end; straight	Output to external indicator	IPC UG-290A/U with contact hole coated	620480
J103	HOLDER, CRYSTAL UNIT: brass; rhodium electro-plate; permanently screwed to panel by 4 screws; fitting on under side of panel is removable so that new crystal can be inserted	Input of auxiliary detector	SPE 619988	619988
J104	CONNECTOR, RECEPTACLE: 1 rd female contact; straight; over-all dim., 1-5/8 in. lg, 0.635 in. dia; incl brass shell, and 0.020 in. dia music wire, 8.5 turns, spring	Detector input	SPE 880926	880926
J105	CONNECTOR, RECEPTACLE: 1 rd female contact; straight; over-all dim., 27/32 in. lg, 7/8 in. dia; contact electrical rating, 500 v; cylindrical shape, silver plated brass body; copolymerstyrene insulators; 1 hole, 0.060 in. - 80 NF- 2 thd; incl brass shell, brass contact, and 0.035 in. dia music wire spring	Cavity output	SPE 836458 Type BNC	836458

TABLE 5-2. LIST OF REPLACEABLE PARTS (Cont)

EQUIPMENT: Wavemeter AN/USM-64(XN-1)

MAJOR COMPONENT: Wavemeter AN/USM-64(XN-1)

Ref. Desig.	Name of Part and Description	Function	Mfr & Desig. or MIL Type	(Cont) Dwg. or Govt. Spec. No.
M101	AMMETER: panel type; direct current type; milliampere, 0 to 30 cw	Indicator	MR36W050DCUAR	720691-03 MIL-M-10304A
P101	CONNECTOR, PLUG: one male contact; straight	Connects J101 to Z101 thru P102	IPC UG-536/U with contact hole coated	820915
P102	CONNECTOR, ADAPTER: 1 male contact one end, 1 female contact other end; 90 deg angle	Connects P101 to frequency meter Z101	AN UG-27 B/U	812980 NAVY DWG RE49F557
P104	CONNECTOR, PLUG: 1 rd male contact, angle type; 90° angle; over-all dim., 1-1/4 in. lg, 9/16 in. wide, 1.0 in. high; contact electrical rating, 500 v; radio frequency connector; nonconstant frequency impedence characteristic; "L" shaped body, brass, silver plated; polytetrafluorethylene insert; 0.212 in. dia max cable opening; cable mounted.	Connects output of crystal detector to switch	IPC Type BNC No. 8525	827600

P105	CONNECTOR, PLUG: 1 male contact; straight, over-all dim; 9/16 in. dia, 1-7/64 in. lg; contact electrical rating, 500 v; radio frequency connector, 50 ohms nominal impedence, constant frequency impedence characteristic; cylindrical shape, silver plated brass body; polytetrofluoroethylene insulator; 0.209 in. max cable opening; 7/16 in. -28NEF-2 thd	Output connector of frequency meter Z101	IPC AN UG-88C/U with contact hole coated	734185
R101	RESISTOR, VARIABLE: 10,000 ohms, ±10%; 2 w	Sensitivity control	RA20A1RD103AK	0193-24 JAN-R-19
R102	RESISTOR, FIXED, COMPOSITION: 240 ohms, ±5%; 1/2 w	Meter shunt	RC20BF241J	069-34 MIL-R-11
S101	SWITCH, TOGGLE: SPDT: w/o luminous tip; "on--none--on"	Function selector	ST42D	0232-4 JAN-S-23
Z101a	CAVITY, TUNED: 900 to 1530 mc frequency range; rhodium plated brass enclosure; rhodium plated inner wall; manually tuned by rotating vanes; 12 in. lg, 3-45/64 in. high; measurement of frequency	A direct reading, coaxial cavity frequency meter for the range of 900 to 1530 mc	SPE 618508	618508

TABLE 5-2. LIST OF REPLACEABLE PARTS (Cont)

EQUIPMENT: Wavemeter AN/USM-64(XN-1)

MAJOR COMPONENT: Wavemeter AN/USM-64(XN-1)

Ref. Desig.	Name of Part and Description	Function	Mfr & Desig. or MIL Type	(Cont) Dwg. or Govt. Spec. No.
Z101b	CAVITY, TUNED: 1510 to 2600 mc frequency range; rhodium plated brass enclosure; rhodium plated inner wall; manually tuned by rotating vanes; 8-27/32 in. lg, 3-45/64 in. wide, 4-3/4 in. high, measurement of frequency	A direct reading, coaxial cavity frequency meter for the range of 1510 to 2600 mc	SPE 619193	619193
Z101c	CAVITY, TUNED: 2580 to 4440 mc frequency range; rhodium plated brass enclosure; rhodium plated inner wall; manually tuned by rotating vanes; 8-11/64 in. lg, 3-45/64 in. wide, 4-3/4 in. high, measurement of frequency	A direct reading, coaxial cavity frequency meter for the range of 2580 to 4440 mc	SPE 619192	619192
Z101d	CAVITY, TUNED: 4400 to 7580 mc frequency range; rhodium plated brass enclosure; rhodium plated inner wall; manually tuned by rotating vanes; 9-5/32 in. lg, 3-45/64 in. wide, 4-17/32 in. high, measurement of frequency	A direct reading, coaxial cavity frequency meter for the range of 4400 to 7580 mc	SPE 619191	619191

Z101e	CAVITY, TUNED: 7500 to 12,400 mc frequency rnage; rhodium plated brass enclosure; rhodium olated inner wall; manually tuned by rotating vanes; 8-1/4 in. lg, 3-45/64 in. wide, 4-33/64 in. high; measurement of frequency	A direct reading, coaxial cavity frequency meter for the range of 7500 to 12400 mc	SPE 619194	619194
Unit No. 8	CABLE ASSEMBLY, RADIO FREQUENCY: AN, radio frequency cable, Type No. RG-58/U, coaxial, 53.5 ohms characteristic impedance, 1900 v rms max operating voltage; solid single conductor, no. 20 AWG, plain finish copper wire, polyethylene dielectric, 0.116 in. OD, single tinned copper shield, rd shape, 0.200 in. dia over-all cross-section dim., black vinyl jacket; assy 26 in. lg over-all, assy 24 in. lg, excluding terminations; 2 AN Type UG-18 C/U plugs located one ea end	Establishes RF circuit connections	SPE 746781	746781

TABLE 5-2. LIST OF REPLACEABLE PARTS (Cont)

EQUIPMENT: Wavemeter AN/USM-64(XN-1)

MAJOR COMPONENT: Wavemeter AN/USM-64(XN-1)

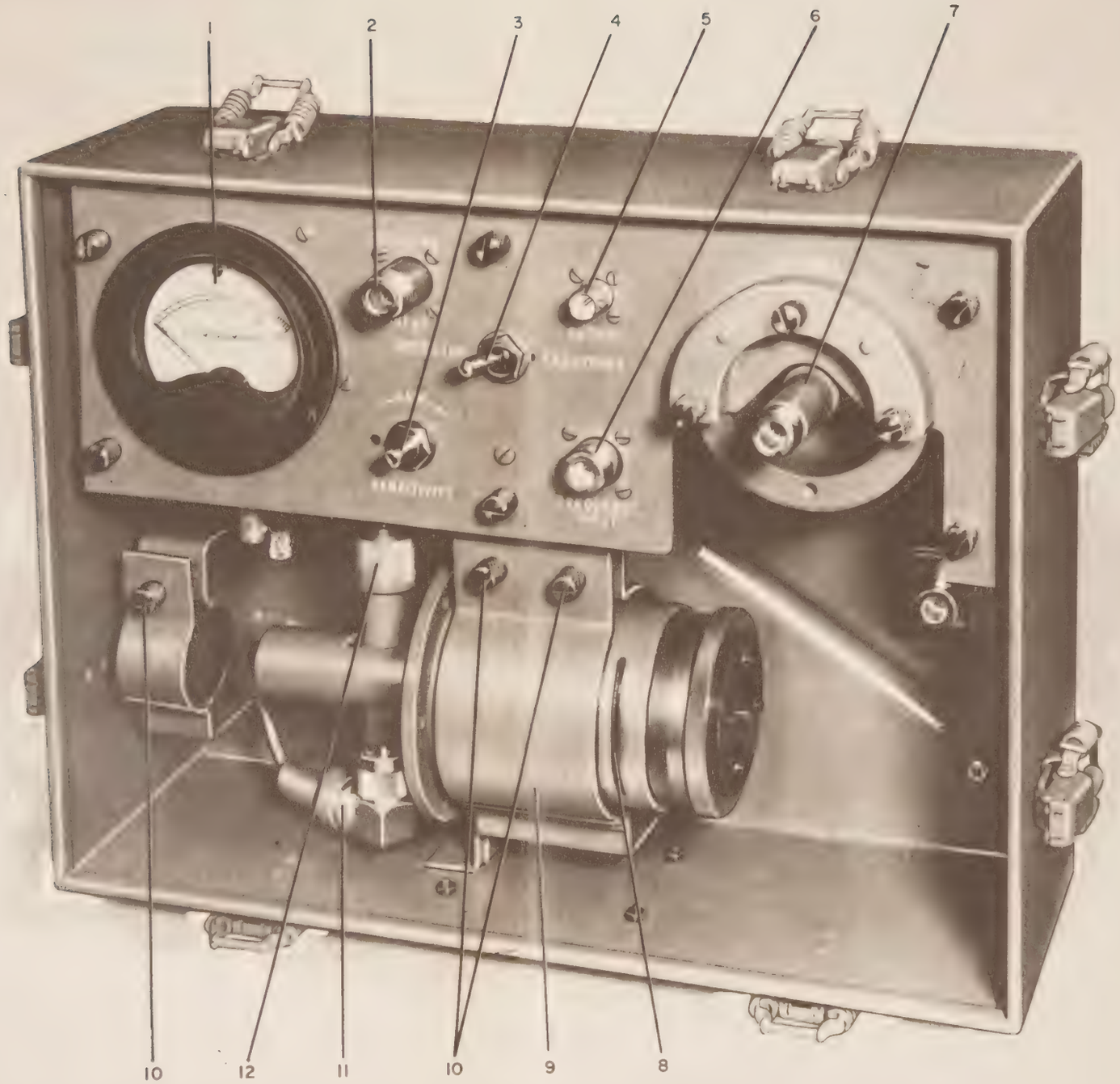
Ref. Desig.	Name of Part and Description	Function	Mfr & Desig. or MIL Type	(Cont) Dwg. or Govt. Spec. No.
Unit No. 9	CABLE ASSEMBLY, RADIO FREQUENCY: AN, radio frequency cable, Type No. RG-58/U, coaxial, 53.5 ohms characteristic impedance, 1900 v rms max operating voltage; solid single conductor, no. 20 AWG, plain finish copper wire, polyethylene dielectric, 0.116 in. OD, single tinned copper shield, rd shape, 0.200 in. dia over-all cross-section dim., black vinyl jacket; assy 26 in. lg over-all, assy 24 in. lg, excluding terminations; 1 AN Type UG-18 C/U plug located on one end, 1 AN Type UG-88 plug located on other end	Establishes RF circuit connections	SPE 746780	746780
Unit No. 10	ADAPTER, CONNECTOR: one rd male and two rd female contacts; tee shaped	Divides RF energy	UG-107/U	812979 JAN-C-71

NOTE

1. Figure 1-1 is incomplete because four additional cavities were not available at the time of submittal of the manuscript copy.

2. Figures 6-2 and 6-5 are not included because these are to be reduced copies of engineering drawings which were not available at time of submittal.

3. Figures 6-6 through 6-11 will not be printed as turn pages in the final book.



1	Microammeter	7	ANTENNA storage mount
2	DETECTOR INPUT connector	8	Direct-reading scale
3	SENSITIVITY control	9	Interchangeable tuned cavity
4	Meter Switch	10	Cavity hold-down clamp and thumb screws
5	OUTPUT connector	11	Cavity plug-in input connector
6	FREQUENCY INPUT connector	12	Cavity plug-in output connector

FIGURE 2-1 WAVEMETER AN/USM-64(XN-1), OPERATING CONTROLS, INDICATORS, AND CONNECTORS

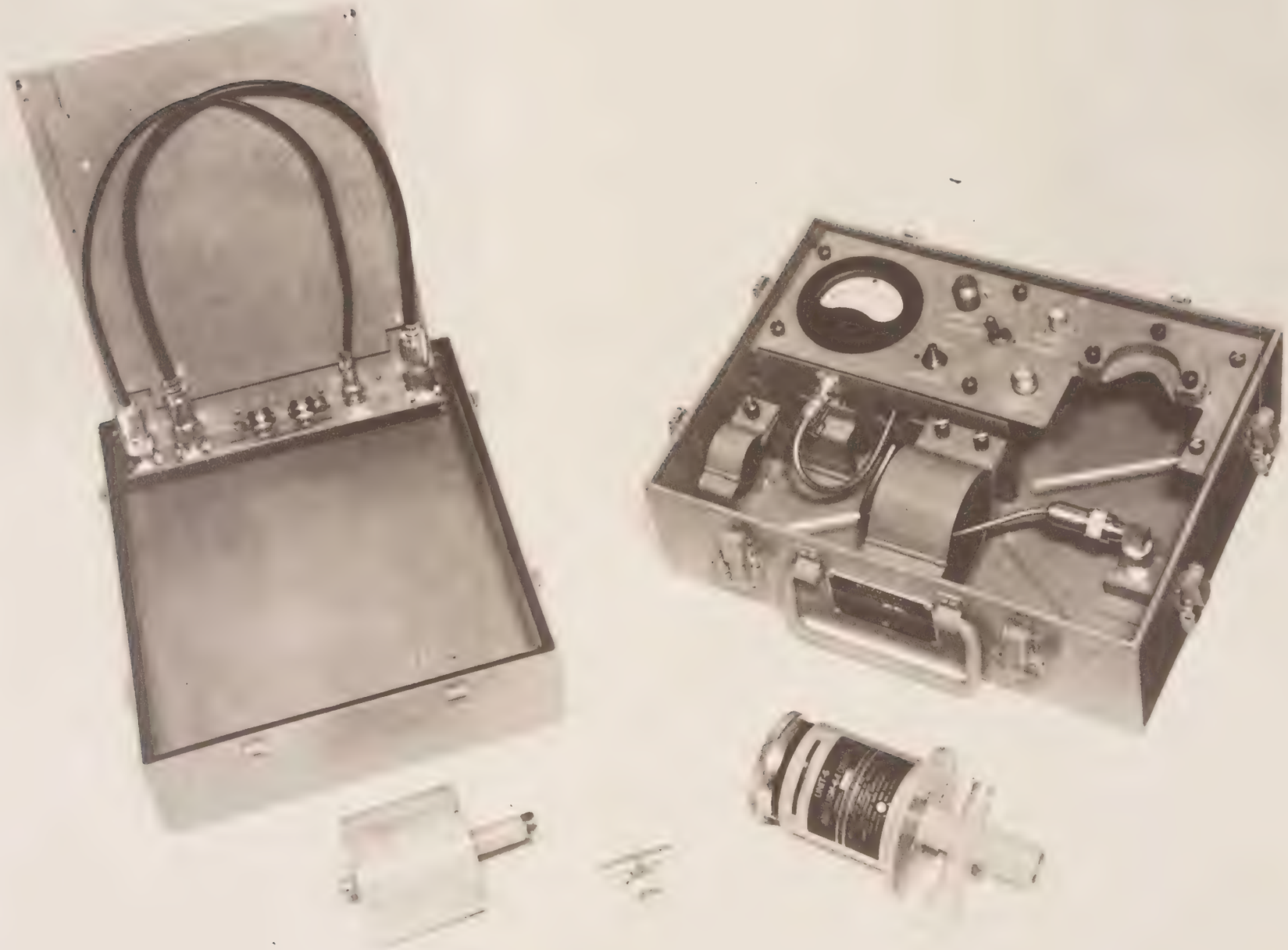
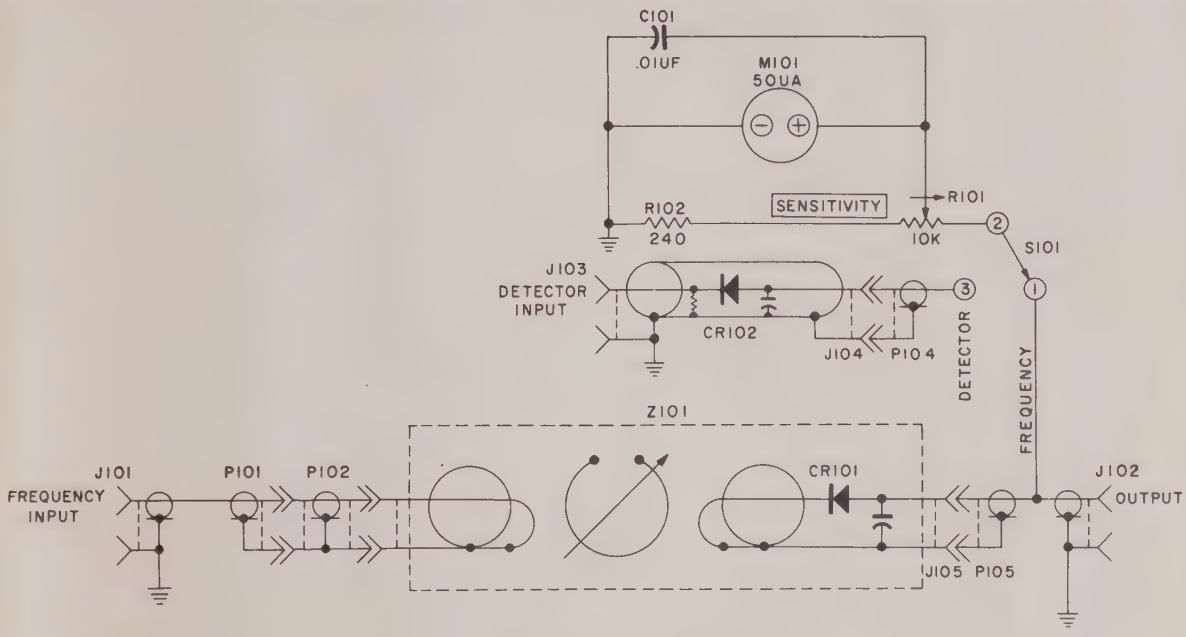


Figure 1-1 Equipment Supplied
(four cavities will be added prior to printing)



SYMBOL	PART NO.	RANGE
Z101a	618508	900-1530MC
Z101b	619193	1510-2600MC
Z101c	619192	2580-4440MC
Z101d	619191	4400-7580MC
Z101e	619194	7500-12400MC

NOTE:

1. Z101a THRU Z101e ARE INTERCHANGEABLE FREQUENCY METERS; ONLY ONE IS MOUNTED TO PANEL WHEN IN USE. SEE TABLE FOR PART NUMBERS.
2. ALL VALUES EXPRESSED IN MICROMICROFARADS OR MICROHENRIES UNLESS OTHERWISE INDICATED. K DENOTES 1,000 OHMS. MEG DENOTES 1,000,000 OHMS.

FIGURE 6-1. WAVEMETER AN/USM-64(XN-1)
SCHEMATIC DIAGRAM

This Drawing Not Available

FIGURE 6-2 WAVEMETER AN/USM-64(XN-1), PRACTICAL WIRING DIAGRAM

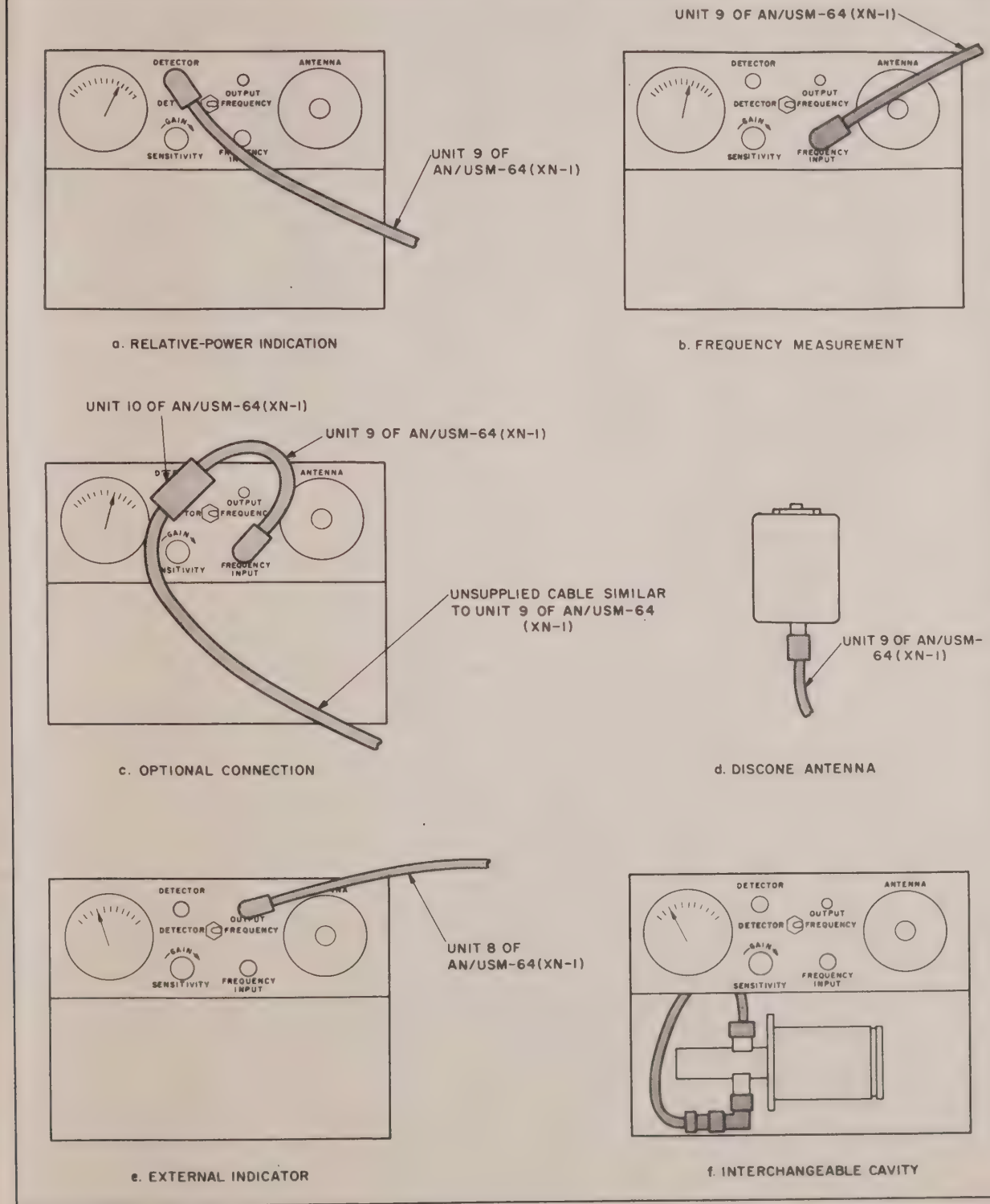
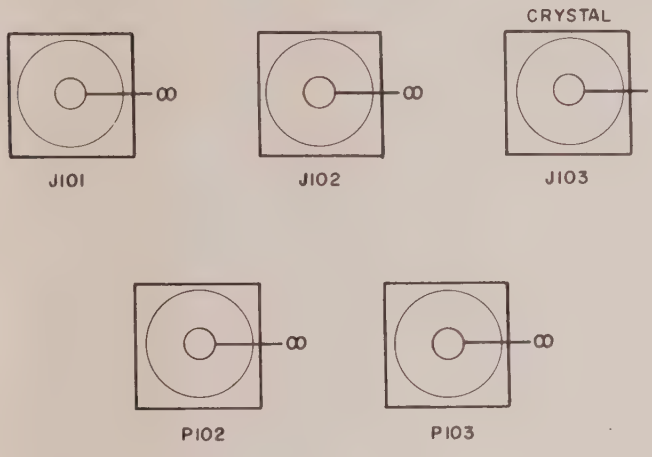
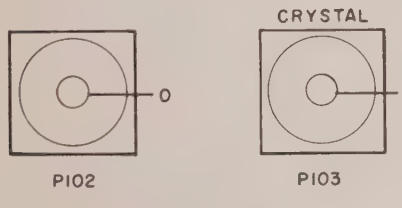


FIGURE 6-3 EXTERNAL WIRING DIAGRAM



(a) TEST SET



(b) CAVITIES

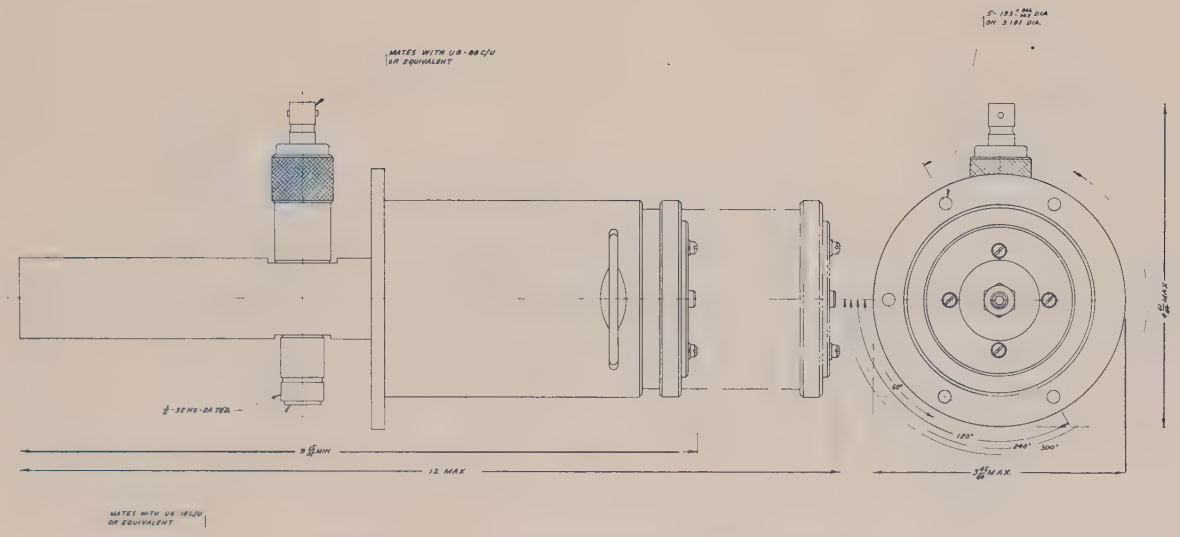
NOTES:

1. ALL RESISTANCE READINGS MEASURED TO GROUND.
2. ALL RESISTANCE READINGS MEASURED WITH INTERCHANGEABLE CAVITIES REMOVED.
3. "METER" SWITCH IN "DETECTOR" POSITION.

FIGURE 6-4. TERMINAL RESISTANCE DIAGRAM FOR EXTERNAL CONNECTORS

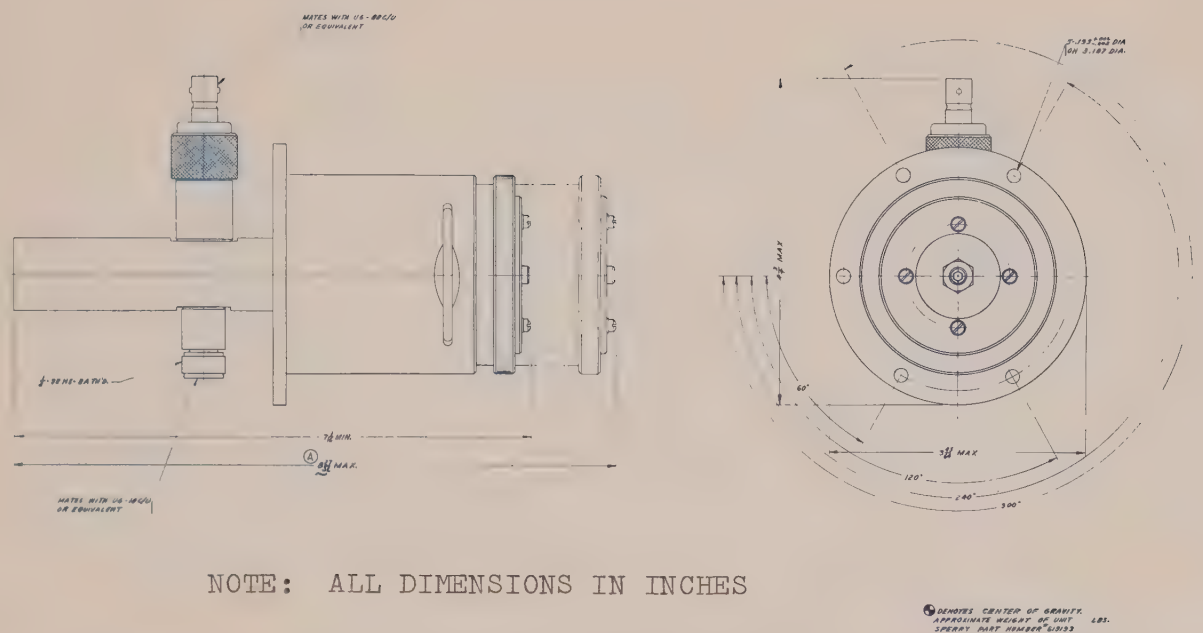
This Drawing Not Available

FIGURE 6-5 UNIT I OF WAVEMETER AN/USM-64(XN-1), OUTLINE DIMENSIONAL DRAWING



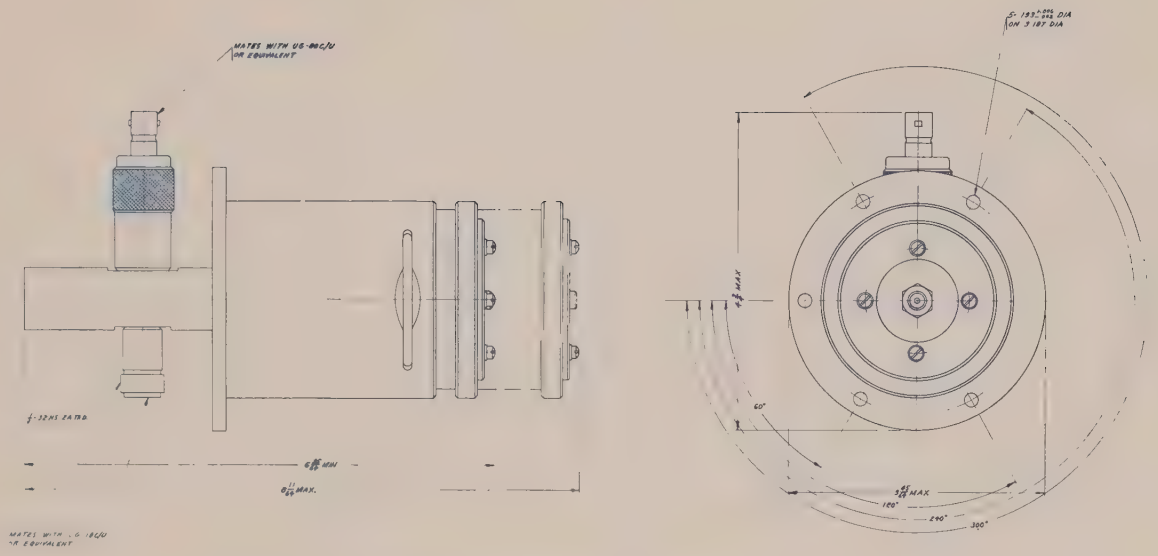
NOTE: ALL DIMENSIONS IN INCHES

Figure 6-6. Unit 2 of Wavemeter AN/USM-64(XN-1), Outline Dimensional Drawing



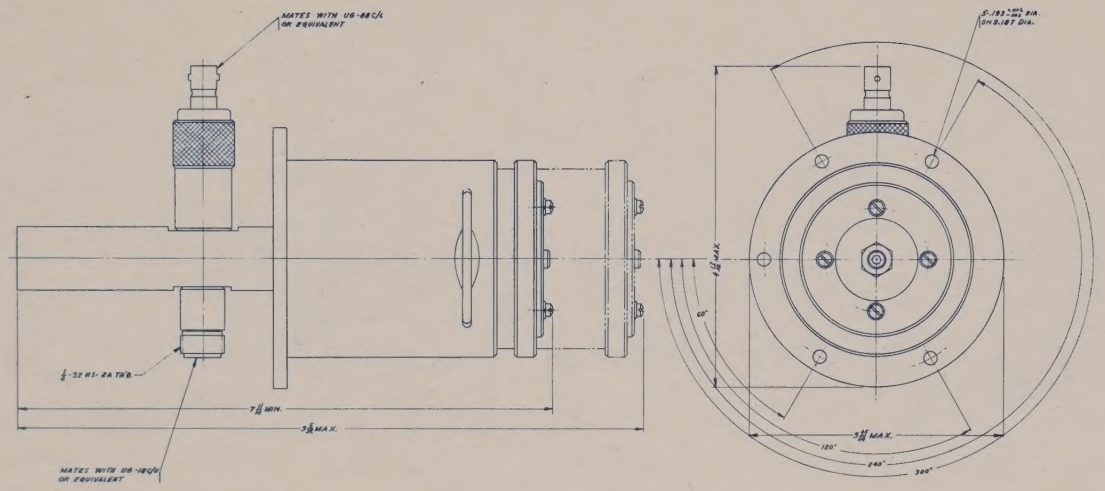
NOTE: ALL DIMENSIONS IN INCHES

Figure 6-7. Unit 2 of Wavemeter AN/USM-64(XN-1), Outline Dimensional Drawing



NOTE: ALL DIMENSIONS IN INCHES.

Figure 6-8. Unit 4 of Wavemeter AN/USM-64(XN-1), Outline Dimensional Drawing



NOTE: ALL DIMENSIONS IN INCHES

Figure 6-9. Unit 5 Wavemeter AN/USM-64(XN-1), Outline Dimensional Drawing